Soil Horizons

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A newsletter communicating our work in soil-related research to end-users, customers and colleagues.

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Manaaki Whenua
Landcare Research

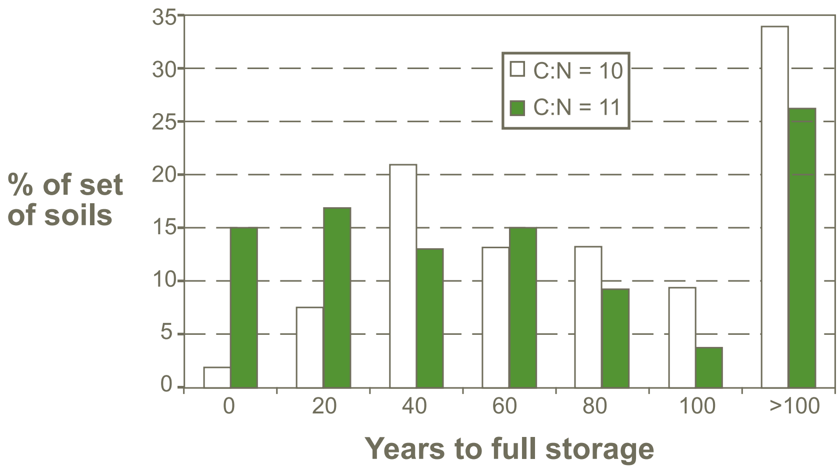
Nitrogen overload

Organic effluents and fertilisers spread on paddocks, and clover growing in pasture, all add nitrogen to soils. Nitrogen not used by growing plants can leach down through the soil to pollute ground-water and (eventually) surface water. Natural processes in the soil, including denitrification and nitrogen storage, help reduce leaching. But land managers need some indication of how long soils can continue to store the excess nitrogen so that fertiliser is not wasted and risks to ground water are minimised.

Using data from the National Soils Database (NSD), Louis Schipper and Harry Percival have attempted to predict potential nitrogen storage, including time to full capacity, for 53 pasture soils in the Waikato Region.

Carbon in pasture soils is generally considered to be in a steady state (i.e. not increasing or decreasing), and the carbon to nitrogen ratio (C:N – weight:weight) in soils rarely falls below 10. Hence, Louis and Harry calculated the total amount of carbon (kg ha^{-1}) in the top metre of soil, then divided this by 10 to get the *maximum nitrogen storage potential* (kg ha^{-1}) of each soil. Finally, they subtracted the amount of nitrogen in the soil profile (data also derived from the NSD) from the maximum potential nitrogen storage to determine the remaining unused nitrogen storage potential of the soil.

How rapidly this potential is used up depends on how rapidly soils store the nitrogen being applied. Louis and Harry assumed an annual nitrogen storage rate of 50



Percent distribution of the 53 soils in the Waikato Region for the time taken to reach full nitrogen storage capacity if nitrogen is applied at 50 kg N/ha/yr.

kg ha^{-1}, then calculated the number of years before storage capacity would be reached or exceeded at the C:N ratio of 10.

There is a huge variation in the length of time various Waikato soils would take to reach maximum storage capacity, as shown (see Figure). A significant percentage of the soils, about 9%, may have already reached their nitrogen storage capacity (0 years in Figure). Some gley soils seem particularly vulnerable to this. The remaining soils would potentially reach full capacity in times ranging from less than 20 years to >100 years. Once soils reach their maximum potential capacity, nitrogen leaching is expected to increase markedly if land managers continue to apply nitrogen at the same rate.

There are a number of critical questions that require investigation: what is the minimum C:N ratio (10 or 11 – see implications in Figure, page 1)? how does it vary between soils? and at what rate is nitrogen stored in different soils?

Despite many unknowns, it is very clear that different soils have vastly different abilities to store nitrogen – differences that should be taken into account when determining long-term nitrogen budgets for different land uses.

Louis Schipper
Ph: 07 858 3735
schipperl@landcare.cri.nz

Improving economics of forestry

Soil surveys are valuable forestry resources for: planning future fertiliser programmes; planning winter harvesting programmes by showing where trees are on well-drained soils to minimise soil compaction; identifying erosion-sensitive areas enabling harvesting methods to be adjusted; and identifying root-restricting layers and where deep-ripping may be required. Further, once foresters become familiar with the benefits of a soil survey for forestry operations, they are better able to apply the knowledge to other forested areas with similar soil types.

Soil surveys of several pine forests, mostly in the central North Island, have been carried out by Wim Rijkse of Landcare Research, Hamilton, for a number of production forestry companies. The forests cover some 415 000 ha and include the Rotoehu, Rotoiti, Tarawera, Whakarewarewa, Kaingaroa, Kinleith, Omataroa and Mahurangi Forests. Map scale has varied from 1:20 000 to 1:100 000, depending on the size of the forest, the purpose of the survey and the most cost-effective scale for meeting the particular information needs.

Recent surveys have used 20 m contour maps as the base for showing soil boundaries. Soils are separated on the basis of topography, differences of parent material, thickness of layers, natural drainage and other pedological processes that make a difference to forest growth and health. For example, in the central North Island, soils derived from water-sorted pumice are of interest because they have poorer fertility for radiata pine than other soils. If foresters know the extent and location of these soils, they can be vigilant for early signs of nutrient deficiency, which shows earlier in radiata pine here than on others soils.

Chemistry and physical structure of soils also affect tree growth – and therefore the profitability of forestry. Chemical analyses of key soils comprise pH, total carbon and nitrogen, Bray extractable phosphorus, available boron, base saturation, exchangeable calcium, magnesium, potassium, and sodium. Physical analyses may include dry bulk density, total and macroporosity, and total and readily available water for the upper metre of soil.

Surveys include identifying the presence and extent of root-restricting layers, natural soil drainage, erosion sensitivity, predictions of soil compaction during harvesting, erosion, and available nutrient levels.

Workshops and field visits can be organised to familiarise foresters with the soils and soil-related problems.

Wim Rijkse
Ph: 07 858 3712
RijkseW@landcare.cri.nz

Erosion and carbon

When people think of greenhouse gas emissions, they generally think of air pollution from burning fossil fuels and, in New Zealand's case, methane emitted by cows and sheep. Few suspect that our national carbon stocks and net greenhouse gas emissions may also be significantly affected by soil – or the loss of it through erosion. Soil erosion is not directly linked to the atmosphere, so how does it affect greenhouse gases, and why is it important?

Soils act as a sink for carbon dioxide (CO_2) from the atmosphere, trapping and storing large quantities of carbon in organic material such as forest litter, and inorganic compounds. When hillslope soils erode, carbon stored in the soil is lost in the sediment washed into rivers and subsequently deposited on to floodplains or carried out to sea. Loss of soil reduces the nation's ability to absorb rising levels of atmospheric CO_2. In addition, carbon can be released to the atmosphere from soils and sediments, through microbial and biogeochemical processes.

New Zealand has a relatively high rate of carbon loss from erosion compared with many other Western countries. Initial estimates suggest that the amount of carbon lost through soil erosion may be enough to turn New Zealand from a net sink of CO_2 to a source.

Landcare Research scientists were recently first in the world to publish a carbon budget on a national scale.

A major project is now underway to refine New Zealand's national carbon budget by taking into account the amount of carbon lost from eroded soil, and released from soil into the atmosphere. Understanding the processes that convert soil carbon into atmospheric CO_2, and quantifying the amount of carbon released from the soil into the atmosphere are important aspects of the research. The project will determine what happens to carbon as soil is transported from land to the sea, and will combine the expertise on soil, riverine, and marine processes of scientists from Landcare Research and NIWA, private consultant Dr David Giltrap, and PhD student Hannah Brackley. Three new staff have joined Landcare Research from the United States, Germany and Russia, to share their skills and experience.

The emphasis of the research is to find ways to mitigate carbon losses – an important issue in terms of the Kyoto Protocol. Under Protocol terms, soil can be recognised as an atmospheric carbon sink, but only if the carbon recovery is human-induced, and verifiable through scientific evidence. Therefore, carbon sinks may become a marketable commodity if countries are permitted to use them to meet their international obligations. Results of this research will help us understand and predict the impacts of land-use change and climate variability on carbon transfer, both at catchment scales, and for the whole country.

Noel Trustrum
Ph: 06 356 7154
TrustrumN@landcare.cri.nz

Two of the new staff working on the erosion-carbon project – Drs Aleksey Sidorchuk from Moscow State University and Troy Baisden from the University of California, Berkeley.

Microbial degradation of atrazine

Atrazine, a triazine herbicide used to control annual grasses and broadleaf weeds in crops, has been detected at low concentrations in New Zealand groundwaters. Atrazine is not readily broken down, and its persistence and movement through soils are key factors in its potential to contaminate groundwater. The behaviour of pesticides in New Zealand soils is being investigated at trial sites with very different soil characteristics – a basaltic soil in Northland and a sandy soil in Manawatu. A mix of pesticides, including atrazine, was applied to the sites at approximately seven times the rate normally used for agriculture.

Soils at the trial sites were sampled at regular intervals and analysed in the laboratory to determine potential rates of atrazine degradation. At the Northland site, significant rates of atrazine degradation were detected in topsoil after 3 months and in subsoil 6 months after application.

> *Atrazine, a herbicide used to control annual grasses and broadleaf weeds in crops, has been detected contaminating New Zealand groundwaters at low concentrations.*

This degradation became more pronounced in soils sampled 9, 12 and 15 months after application. In contrast, atrazine degradation in topsoils from the Manawatu site was variable. Some degradation was detected in topsoil 6 months after application but none in the subsoil. Significant levels of degradation were only detected 12 and 15 months after pesticide application. By 18 months, rates of degradation in soils from both sites had declined.

Numbers of atrazine microbial degraders in the soil from both sites remained low. However, a bacterium, *Arthrobacter nicotinovorans*, was isolated from the Manawatu soil, which degrades atrazine and a related triazine pesticide terbuthylazine as sole sources of nitrogen.

Mineralisation rates of atrazine vary with soil type and management practices. Under similar rainfall, we would expect the groundwater contamination potential beneath sandy Manawatu soils to be greater than that beneath basaltic soil from Northland. As use of atrazine in light-textured soils poses a higher risk of groundwater contamination, more research is required to quantify the risk.

Jackie Aislabie
Ph: 07 858 3700
AislabieJ@landcare.cri.nz

Soil monoliths show land-use changes in Ohakune soils

Soil monoliths provide an historic record of the soil profile, and are invaluable teaching aids for students, field days, agricultural shows, launches of advisory programmes, seminars, meetings and conferences. Soil monoliths are columns of undisturbed soil, cut from a soil profile and impregnated with resin. These monoliths are contained in a wooden frame, and the surface is picked down to reveal the characteristic soil structure, before the surface is sealed with a final coat of resin and permanently mounted on a backboard.

The three monoliths shown on page 5 represent three Ohakune soil profiles developed (from left to right) under native beech-podocarp forest, 55-year-old permanent pasture and 16 years of continuous cropping. The monoliths clearly show that the different land uses have resulted in significant differences in soil morphology.

There are marked differences in the depth, colour and soil structure of topsoil (A horizons) and subsoil (B horizons) in the soil profile. Soil structure is most strongly developed in the native forest soil and is weakest under continuous cropping. The arable soil has also developed a distinctive tillage pan.

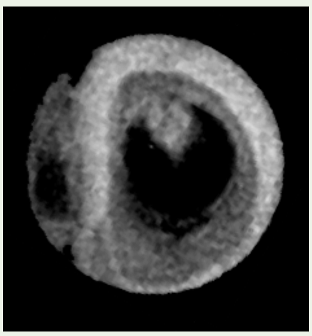
As an indication of organic matter levels, the amount of carbon in the top 0–20 cm (the tillage zone of the cropped soil) was highest under pasture (179 $mgC.cm^{-3}$), intermediate under native forest (157 $mgC.cm^{-3}$, note: this excludes litterfall horizons), and least in the cropped soil (126 $mgC.cm^{-3}$).

The structural degradation after 16 years of continuous cropping and a decrease in organic matter, implies a decreased biological activity in the soil. This is supported by biochemical indices (respiration rates, microbial carbon and anaerobically mineralisable nitrogen), that are all significantly lower in the cropped soil.

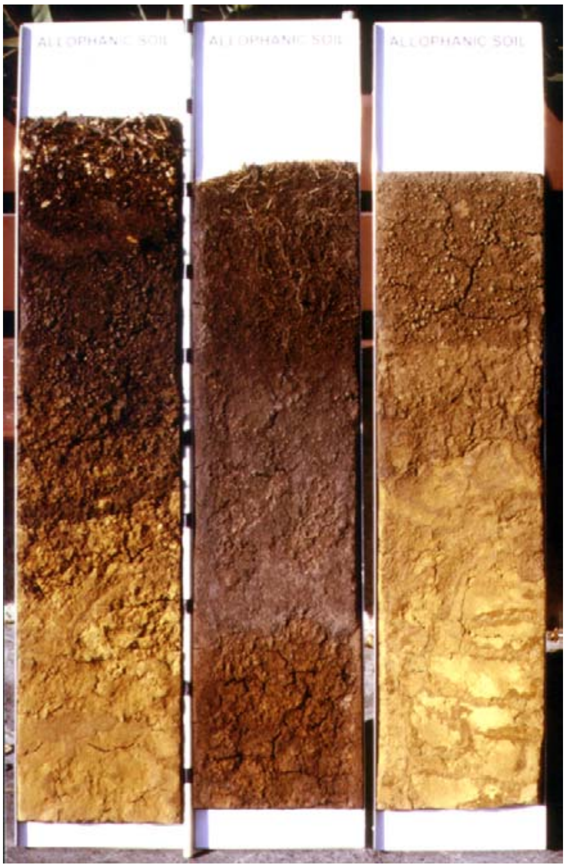
These deleterious changes have obvious implications for the sustained yield output of this intensively cropped soil. The Ohakune region is a significant producer of carrots, producing nearly half New Zealand's 17 000 tonne annual crop, with 4 000 tonnes being shipped from one exporter to Asian markets last year. The findings of this current study show the need to monitor carefully changes to soil under continuous cropping. As well as being a permanent record, the soil monoliths are a powerful visual reminder of the need to assess the impact of intensive use of these highly valued soils.

Craig Ross and Carolyn Hedley
Ph: (06) 356 7154
RossC@landcare.cri.nz or
HedleyC@landcare.cri.nz

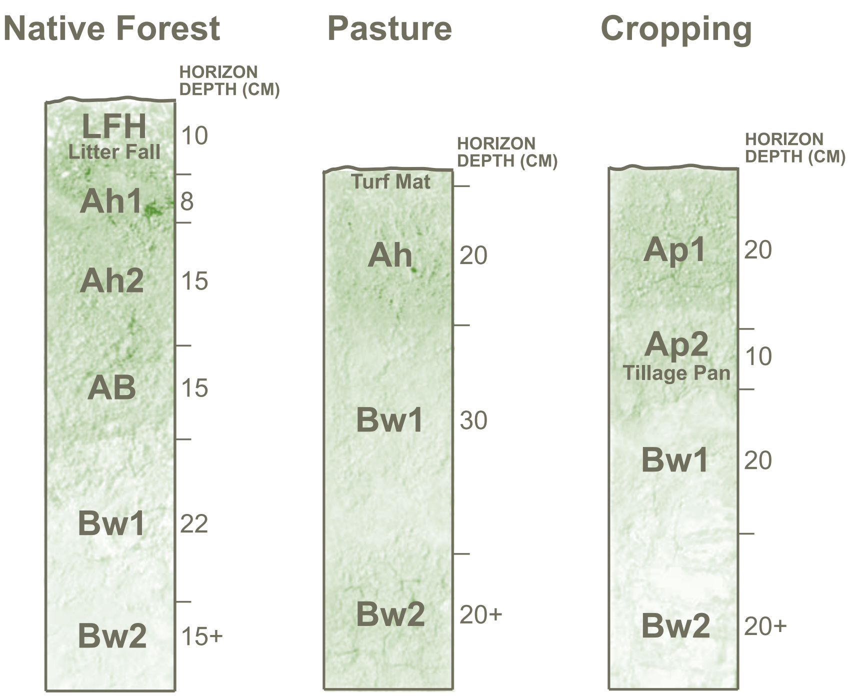
What is it?



Find out on the back page



A set of soil monoliths showing morphological differences between the Ohakune silt loam developed under (from left to right): native beech-podocarp forest, permanent pasture, long-term cropping.



Pedological differences between the three soil profiles

Urban development and soils

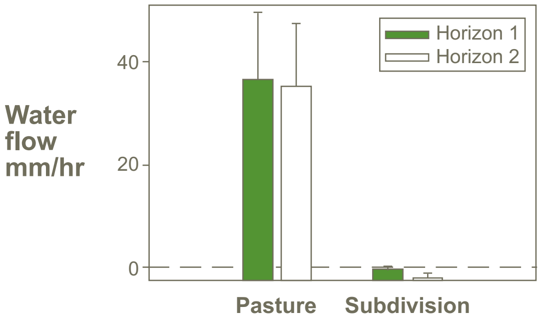


Figure 1

Water flow (saturated hydraulic conductivity, mm/hr) through pasture soils and earthworked soils found in urban subdivisions on Kainui silt loam. Dashed line indicates a rainfall rate of 2 mm/hr.

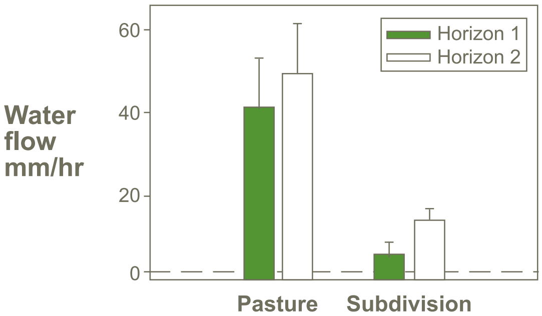


Figure 2

Water flow (saturated hydraulic conductivity, mm/hr) through pasture soils and earthworked soils found in urban subdivisions on Te Kowhai silty clay. Dashed line indicates a rainfall rate of 2 mm/hr.

Creating new urban subdivisions involves major alterations to the landscape. During the earthworking, topsoil is typically stock-piled, while soil from elevated ground may be shifted to fill in hollows ("cut and fill"). The subsoil – which forms the base for building foundations – may become compacted, either intentionally to meet building regulations, or accidentally as a result of vehicle traffic.

Soils are important in urban landscapes as they help regulate water flows to avoid flooding. With large areas of the urban landscape being covered in hard surfaces and buildings, soil in the remaining open spaces needs to be in the best possible condition.

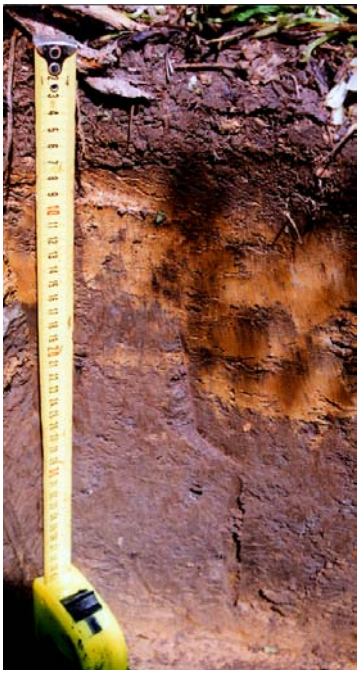
Julie Zanders, Malcolm McLeod and Danny Thornburrow, Landcare Research, Hamilton, have been checking soils to see whether they had been adversely affected during preparation for urban development. They measured water flow, storage and drainage in soils in urban subdivisions and compared these with the same soil under pasture. Two soil types common around Hamilton – the Kainui silt loam (on rolling land) and Te Kowhai silty clay (on alluvial flats) – were studied, with soil cores being taken from the top two horizons.

Earthworks adversely affected both soils, with the Kainui soil being most affected. Water flow through both soils was much slower at subdivision sites (Figs 1 and 2). Cut and fill operations at the Kainui subdivision sites resulted in loss of the permeable Horizon 2 that was seen at pasture sites. In its place is a compacted clay layer (Horizon 2 for subdivision sites) that allowed virtually no percolation of water – in Figure 1 the bar showing flow through Horizon 2 of the subdivision soil is barely visible above the x-axis. As this clay layer is now near the surface (between 17 and 40 cm), and has minimal infiltration, it will play a critical role in restricting water infiltration and drainage. With rainfall of 2 mm/hr, a rate exceeded by perhaps 20% of rainfall events, the Kainui subdivision soils are likely to have surface ponding and/or runoff problems. This will worsen if flows from adjacent impervious areas (e.g., driveways, roads, roofs) are added.

The capacity to infiltrate and store water in these subdivision soils could be improved by increasing the depth of topsoil – assuming that the topsoil is put in place without being compacted. Earthworking should ideally be limited to areas where it is essential – this would leave soil not destined for building foundations unaffected and in good condition.

Julie Zanders
Ph: 07 858 3736
ZandersJ@landcare.cri.nz

Problems with layered urban soils



Profile of Anthropic (man-made) fill soil

Soils along streams naturally vary spatially and vertically, depending on the size of flood deposits (coarseness and depth of sediment) and the patterns of old channels. Soil depth and quality can have a major impact on the success of revegetation projects. We characterised soil under four native revegetation trials along the banks of the Opanuku Stream in Waitakere City. These urban sites had imperfectly drained Whakapara clay and silt loams (Mottled Fluvial Recent Soils) before alteration to the original surface by compaction, and in three of the four trials by addition of topsoil and subsoil as fill, during urbanisation.

The main soil change caused by spreading 10 cm of imported topsoil and a variable depth of imported subsoil over the original surface was a characteristic soil strength profile with a peak at the bottom of each imported layer caused by vehicle compaction (Figures 1 and 2). Water and roots were usually blocked at these compacted, high-strength layers, with the potential rooting depth reduced from >50 cm to 10 cm. Although the new topsoils generally had >10% macroporosity, only cabbage trees survived where water could not move laterally. New topsoils also sported distinctive chunks of subsoils, weathered parent rock, gravels, plastic, cloth and wood.

One way to improve these soils is to rip them, as farmers do to break plough pans in cropping land. Where the fill was less than 20–30 cm this was sometimes effective, as it allowed roots to reach buried topsoils. However, ripping had to be aligned so that rainwater flowed out of the rip lines, otherwise ponds were created. The wide variation in subsoil water content, depth of fill, and multiple compacted zones, made effective shattering difficult to achieve. A second solution may be to increase the topsoil depth by spreading a thick (10–15 cm) mulch of woodchips or bark mulch,

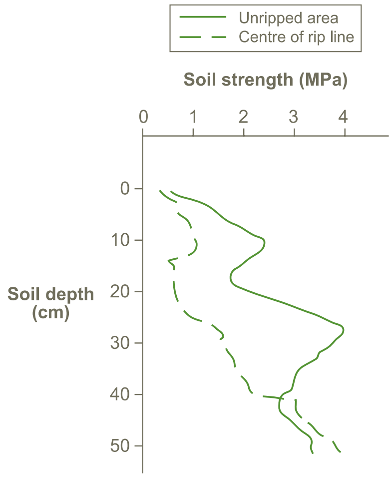


Figure 1

Soil strength profile of Anthropic fill soil

and allowing it to break down for 12–24 months before planting. Mulching slows soil drying. In wet soils, immediate planting into mulch increases the duration of soil saturation, resulting in more plants dying.

Of course, the best solution is not to fill or compact these soils in the first place!

Robyn Simcock
Ph: 09 815 4200
SimcockR@landcare.cri.nz

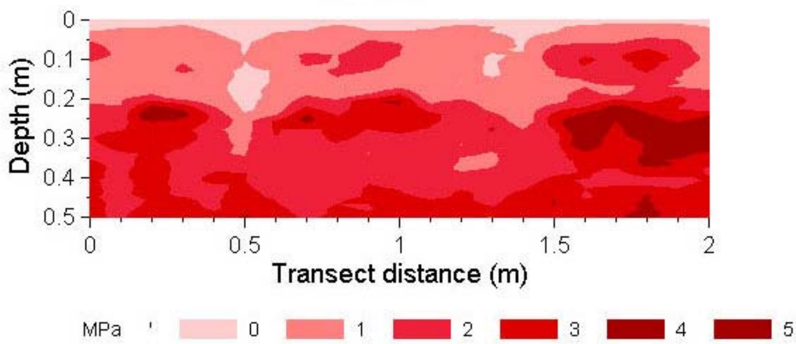


Figure 2

Soil strength in a slice of soil 1.2 m wide and 50 cm deep. Pale tones (<3 MPa) show favourable conditions for roots. Dark areas show compacted zones. The soils was ripped at 0.4 m and 1.3 m along the slice, indicated by pale tones reaching to 30 cm depth.

Background level maps of heavy metals in soils

There is often uncertainty whether concentrations of heavy metals in soils at particular sites reflect contamination or whether they are just what could be expected as natural background levels supplied by soil parent materials.

Until recently, the only available maps containing heavy metal information were a series of "single factor" maps for several heavy metals in topsoils. These were produced by the New Zealand Soil Bureau (a division of the former DSIR) in the 1960s and '70s. They were at a national scale and did not provide regional detail, nor include subsoil data, they were also limited in the metals covered. Further-more, the analytical methods used at the time had some accuracy limitations.

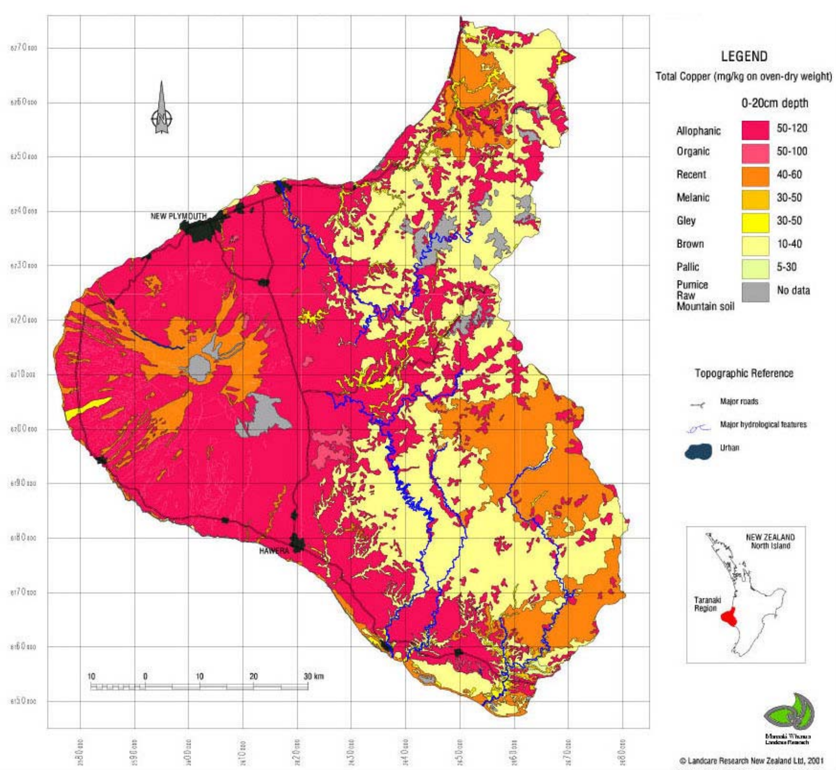
When the National Soils Database (NSD) was set up, soil profiles were collected and analysed in our soil chemistry laboratories. Heavy metal concentrations (mg/kg) have been determined for some of these soil profiles using more accurate X-ray fluorescence spectroscopy techniques.

Harry Percival and Anne Sutherland recently completed a pilot regional study, using the Taranaki Region as a test area, on typical or background concentrations of selected heavy metals (chromium, copper, lead, nickel, vanadium, and zinc) in topsoils and subsoils taken from the NSD database.

Once the data was extracted from the NSD it was categorised into Soil Orders and three depth intervals (topsoil 0–20 cm, and subsoils 20–60 cm and 60–100 cm). There are nine Soil Orders represented in the Taranaki Region, but because of the "patchy" distribution of 19 soils with heavy metal data within the region, only some of the Soil Orders had adequate data to estimate the expected background range of metal concentrations with confidence (i.e. 90% probability). Where possible, for those Soil Orders with little or no metal data, relevant data from other parts of the North Island were used.

Harry Percival
Ph: 06 356 7154
PercivalH@landcare.cri.nz

TOTAL COPPER 0–20 cm IN SOILS OF THE TARANAKI REGION

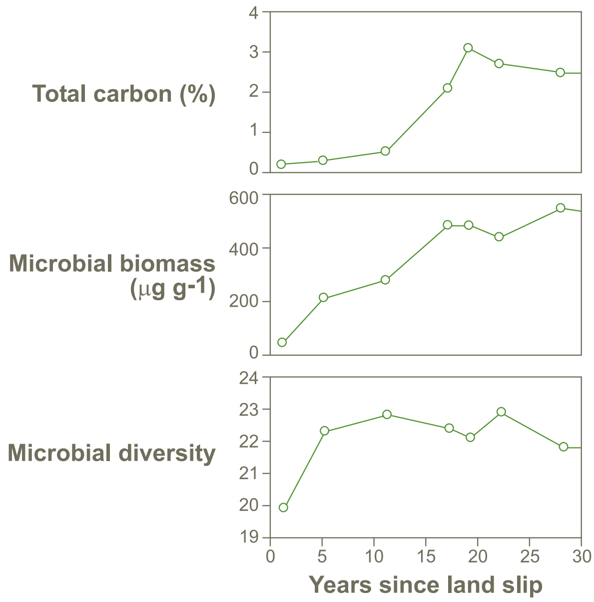


Soil Horizons is on the web

View this map in colour on http://www.landcare.cri.nz/information_services/publications/newsletters/soilhorizons

After soil slips ....

There are a wide range of internationally accepted indicators for monitoring changes in soil quality due to differing land uses. However, little is known about the relative sensitivity of these different indicators to monitoring soil recovery after major disturbances such as soil slips.



The recovery of total carbon, microbial biomass and microbial diversity with time after a soil slip

Louis Schipper and Graham Sparling, Landcare Research, Hamilton, have been investigating how quickly the biological properties of soil recover following a landslip. Louis and Graham enlisted help from Mark Smale, a Landcare Research botanist, and sampled a series of slip sites where Mark had previously studied vegetation recovery. These slips, selected for this soil recovery study, were of different ages (up to 30 years old) and on the same soil type with the same aspect and vegetation cover. A wide range of soil quality indicators and microbial diversity was measured.

The researchers found that three key indicators, i.e. microbial diversity, microbial biomass and total carbon, recovered at very different rates (see Figure). Microbial diversity measures the range of different microbes present, microbial biomass measures the size of the microbial community, and total carbon is a direct measure of the total amount of organic matter.

Microbial diversity was a very sensitive indicator of initial phases of recovery, particularly of the first 5 years. This period would be critical for soil stabilisation at the site, with initial recolonisation by microbes making nutrients available for revegetation by various plant species. Microbial biomass did not recover as quickly as diversity, but increased steadily throughout the 30 years, as the slip continued to be recolonised and revegetated. Total carbon, the traditional measure of soil organic matter, showed very little recovery for the first 10 years but reached its maximum after 18 years. These results suggest that the initial recovery period is dominated by rapid recolonistion by a varied microbial population whose mass slowly increased over the 30 years of the study. The significantly greater increase in total carbon between 10 and 20 years suggests that revegetation of the site was considerable during this time.

To select the "best" indicator to follow recovery depends on whether you are interested in short-term or long-term responses. Microbial biomass or total carbon give a good picture of the longer term trend of soil quality recovery. To get a quick indication of any immediate recovery, microbial diversity measures are useful.

Practical considerations and costs also influence the choice of indicator. Total carbon is offered as a routine analytical service by many commercial laboratories, whereas microbial biomass determination is more complicated, expensive and only offered by a few specialist laboratories. Microbial diversity assessment is yet more complex, and at present is only routinely measured in research laboratories.

This study leads us to recommend that a measurement of microbial activity as well as of total carbon is useful for monitoring soil quality recovery on degraded sites.

Louis Schipper
Ph: 07 858 3700
SchipperL@landcare.cri.nz

Nematode diversity reduced by sewage sludge

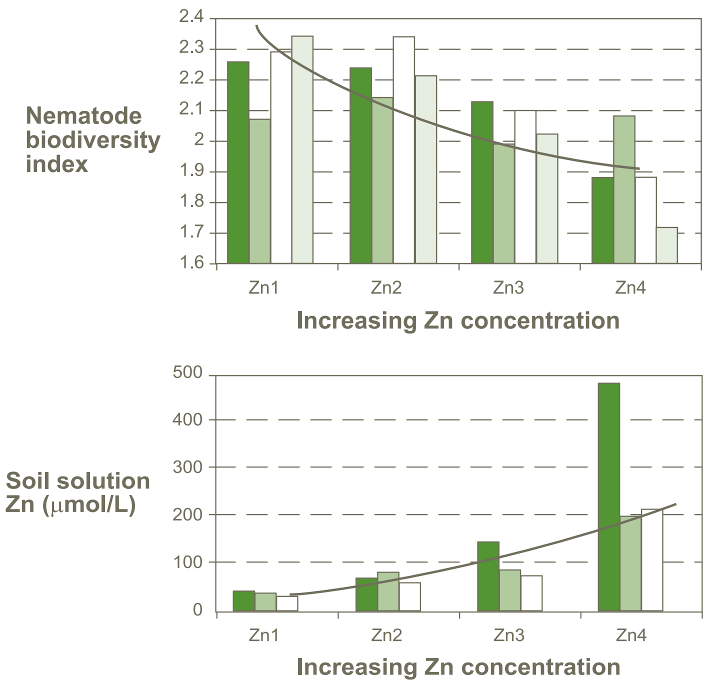
Sewage sludge is often disposed of by being spread on pasture as fertiliser. But sludge may contain high concentrations of heavy metals that can affect the functioning of the soil ecosystem. Heavy metals in soil-solution are the most biologically available fraction of the total heavy metals in soils. Hence metals in soil-solution have potentially the greatest toxic effects on soil biota. The sensitivity of soil organisms and associated biochemistry is being used to assess soil pollution effects and to derive effects-based limits in a pasture trial at Lincoln. Sewage sludge spiked with heavy metals was used to raise total soil metal concentrations to above soil loading guidelines of 140 mg/kg for copper, 35 mg/kg for nickel, and 300 mg/kg for zinc. There were substantial increases in soil solution metal concentrations as a result. This trial is being carried out by Environmental Science and Research (Ltd), Landcare Research, and Lincoln University.

Three to four years after the metal-spiked sludge was added to the trial site, the highest soil- solution concentrations measured have been 4 μmol/litre for copper, 13 μmol/litre for nickel, and 480 μmol/litre for zinc. Over this relatively short time, there have been no adverse effects on soil biochemistry attributable to copper or nickel. However, there have been indications of zinc having an effect at the highest soil-solution concentrations.

As soil biochemistry relates to the activities of soil microorganisms, we were interested to see whether soil microfauna was affected by the higher soil-solution concentrations of metals. Soil microorganisms are important food for microfauna, (including nematodes), and the soil ecosystem is important in controlling the availability of plant nutrients. The Shannon-Weiner Index (H') is used as a measure of nematode biodiversity – conventional wisdom being that lower biodiversity represents reduced ability of soil microfauna to respond to changing conditions.

Over 4 years of sampling, nematode biodiversity has been markedly lower at higher levels of applied zinc. The figure below relates nematode biodiversity to the soil-solution zinc concentrations in the plots receiving zinc-spiked sludge. For 1998–2000, this decline in diversity is correlated with increasing levels of biologically available zinc. In 2001, however, the plots were limed, which reduced the zinc concentrations in soil-solution, but nematode biodiversity did not recover. While there may be short-term seasonal reasons for this, it seems more likely that the nematode fauna has been depleted and that recolonisation from less affected soils will be necessary to re-establish the original nematode diversity. This research continues.

Gregor Yeates and Harry Percival
Ph: 06 356 7154
YeatesG@landcare.cri or
PercivalH@landcare.cri.nz



Effect of increasing zinc concentrations in sewage sludge on the concentration of zinc in soil-solution (bottom graph), and on biodiversity of soil nematodes living in the soil solution (top graph). Data is shown for 1998, 1999, 2000 and 2001. The site was limed in 2001 reducing soil-solution zinc to negligible concentrations.

Oil in Antarctic soils

Antarctic soils are unique and were formed under the most extreme conditions on Earth. Not even the Arctic has such cold and dry conditions. Recent examination of the microbes in contaminated soil has raised the possibility that bioremediation could be used on contaminated soils, with hydrocarbon-degrading bacteria breaking down the pollution.

Dr Jackie Aislabie, a microbiologist with Landcare Research, is leading a programme aimed at understanding how oil spills impact on Antarctic soils. The research team includes Waikato University soil scientist Dr Megan Balks, geochemist Dr Doug Sheppard from Geochemical Solutions, and Drs Ron Paetzold and John Kimble from the USDA.

Properties of pristine soils have been compared with oil-contaminated soil at three locations: Scott Base, Marble Point, and in the Wright Valley at Bull Pass. Soils in the Scott Base area have been affected by the New Zealand base, which has been inhabited continuously for 40 years. Marble Point was inhabited from 1957 to about 1963. At Bull Pass, an oil spill occurred during seismic bore-hole drilling activities in 1985. The contaminated areas at all three sites amount to less than two hectares.

Soil samples were collected from a range of depths, depending on the presence of ice-cemented surfaces or bedrock. Samples were also collected at least 30 m from the contaminated areas. Soil samples for microbial and chemical analysis were stored frozen until analysis in New Zealand. Hydrocarbon levels were elevated in both surface and sub-surface soils at all the contaminated sites. The concentrations varied depending on the type and amount of oil spilt, and the time since spillage. Levels range from below detection limits, to 29 000 micrograms per gram of soil.

Storage tank for jet fuel at McMurdo Station

Contaminated soils contain higher levels of soil carbon, which can act either as a substrate for the growth of microbes, or prove toxic to their growth and activity. In contaminated soils from Scott Base and Marble Point, Jackie and her colleagues found the elevated soil carbon levels increased numbers of *Pseudomonas*, *Sphingomonas* and *Rhodococcus* species, which break down hydrocarbons. While some bacteria were thriving, others were on the decline. The oil spills allowed selective growth of some groups of organisms, but with a decrease in diversity. The effects hydrocarbons could be having on the cycling of nutrients like nitrogen and phosphorus are unknown. So too is the speed at which those bacteria have been working since the oil spills. If bacteria are to be used to clean up soils, we need to investigate how we can get them to work faster. Research work in Antarctica is on-going, and an intentional controlled spillage trial is starting at Scott Base. The intention is to determine how soon soil temperature and microbial activity change after an oil spillage.

Jackie notes that while the research can not yet state categorically the best ways to clean up oil spills on Antarctic soils, it can recommend sensible approaches. Sensible management depends on knowing the site characteristics and soil type of the contaminated areas, and on learning lessons from what has happened in previous spills.

Descriptions and analyses of the soils are being stored in a GIS and an associated Antarctic soils database, managed by Landcare Research. So far, data from more than 700 sites dating back from the late 1950s have been entered. This database, together with other research information, will eventually provide guidelines for visitors to the ice-free regions of Antarctica, so that damage to particularly fragile soils can be avoided.

Jackie Aislabie
Ph: 07 858 3700
AislabieJ@landcare.cri.nz

Have you registered yet?

The **Soil Quality and Sustainable Land Management** Conference is being held between April 3–5, 2002, at Massey University, in Palmerston North.

The conference will consist of 2 days of presentations with ample time for discussions. Presentations (and posters) will focus on soil quality research and its practical applications. Conference sessions will focus on soil quality indicators, soil assessment tools, uptake of research for policy and management, sustainable land management techniques, environmental monitoring systems, and use of the internet as a communication medium and information source. There is also a field trip (covering crop land and hill country issues). A conference proceedings of extended abstracts will be published.

A more detailed conference programme will be posted on the Landcare Research web site at http://www.landcare.cri.nz/conferences/

Manaaki Whenua Landcare Research

CROP & FOOD Mana Kai Rangahau

NEW ZEALAND ASSOCIATION OF RESOURCE MANAGEMENT

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Massey University

Website

Soil Horizons is on the web

http://www.landcare.cri.nz/information_services/publications/newsletters/soilhorizons

What is it?

Answer: NMR cross-sectional image of an earthworm. The darker areas are cavities, the larger one being the intestinal cavity, probably filled with soil. The dorsal infolding of tissue into this cavity is the typhlosole (triangular shape in image), which increases the surface area of the intestine and helps the absorption of food materials. The image was produced on a Bruker AMX300 NMR spectrometer, with the assistance of Professor Paul Callaghan's research team, Massey University.

Key contacts

Editors:	Peter Stephens, Carolyn Hedley, Judy Grindell and Anne Austin
Layout:	Judy Camden
Production:	Peter Stephens Ph: 06 356 7154 StephensP@landcare.cri.nz
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